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GB 1527791
GB 1478293
GB 1214852
GB 948252
GB 918442
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(54) **Pistons for internal combustion engines**

(57) A piston which utilises a cast-in insert for anchoring a combustion chamber bowl lip insert can have the lip insert secured to the cast-in insert before or after the piston body is cast. A composite insert includes a piston ring carrier 12, a seat member 11 for the lip insert 6, and anchoring limbs (15), Fig. 5 (not shown) for the seat member which extend into a suitably cool region of the piston body. The lip insert 6 can be secured to the seat member 11 by laser, electron beam, friction, or resistance welding or by mechanical jointing or brazing either before the composite insert is introduced into the piston body mould or after casting, in which case the seat member is exposed by machining. Means are provided in the piston mould for correct location of the composite insert in the mould.

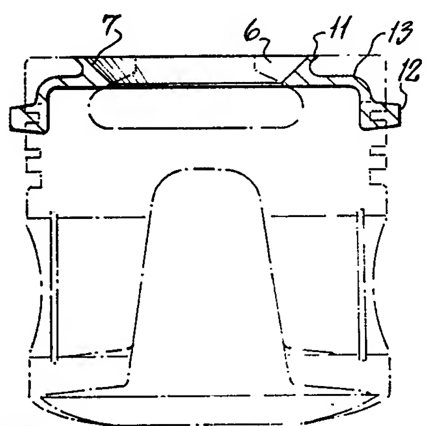

FIG.3

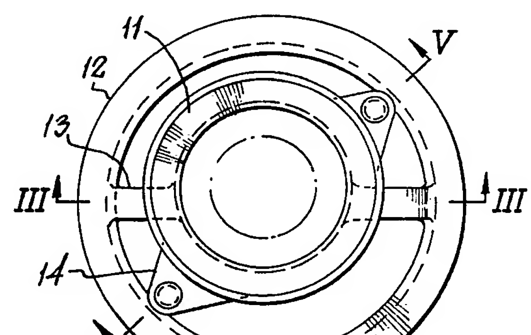

FIG.4

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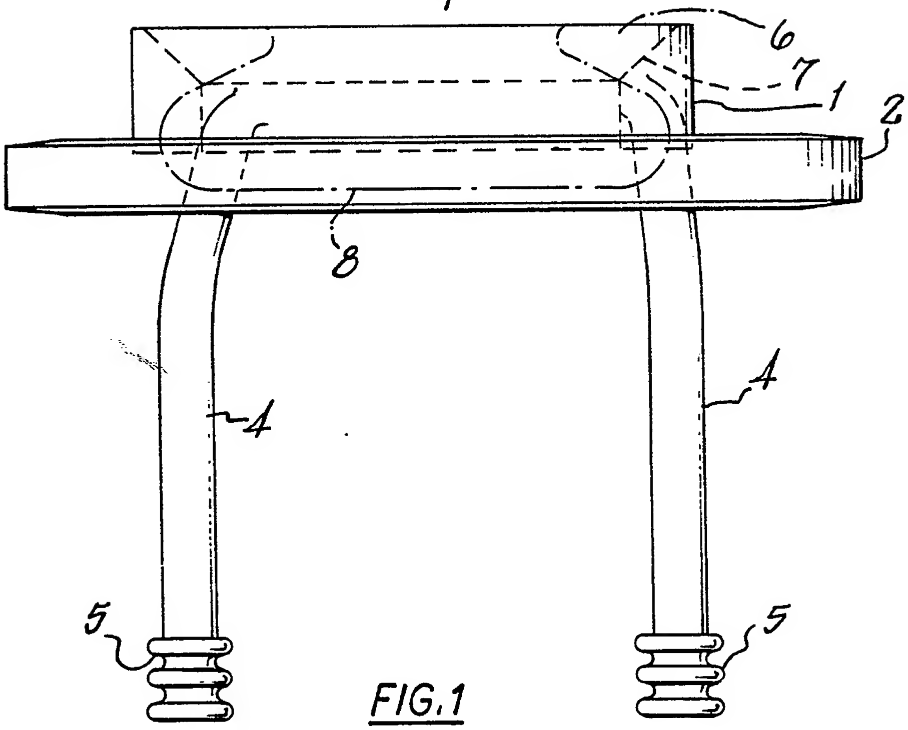

FIG.1

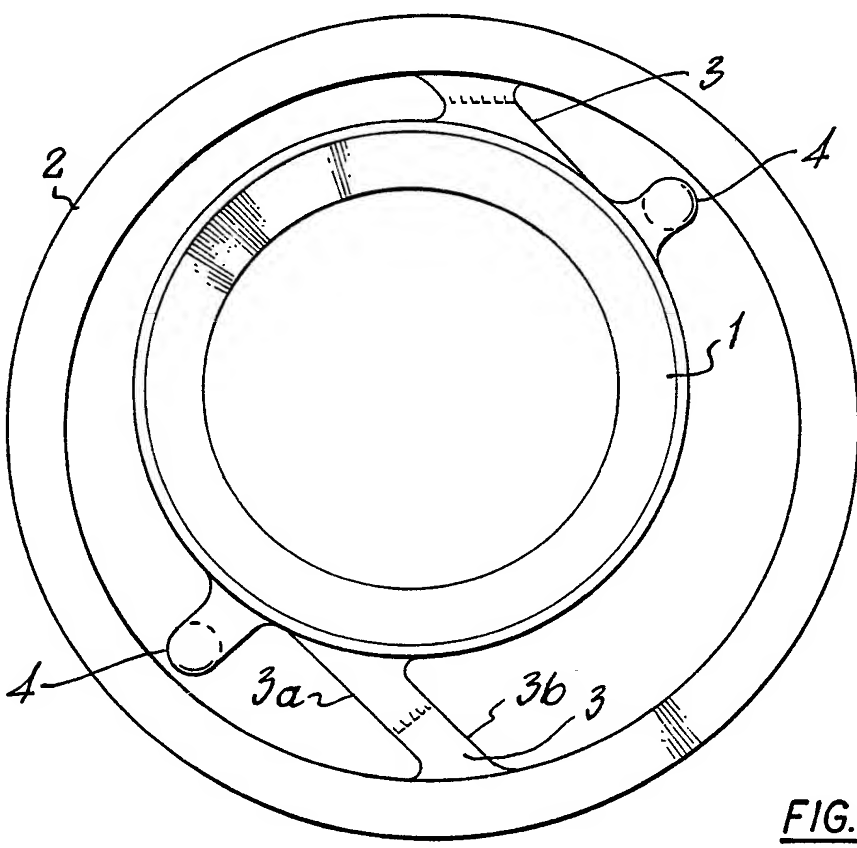

FIG. 2

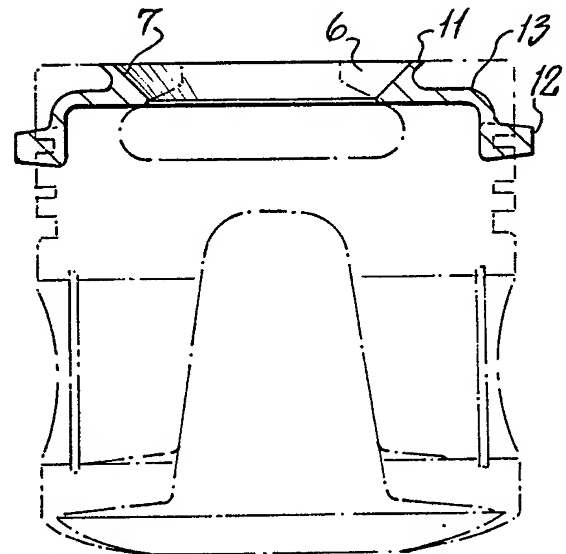

FIG.3

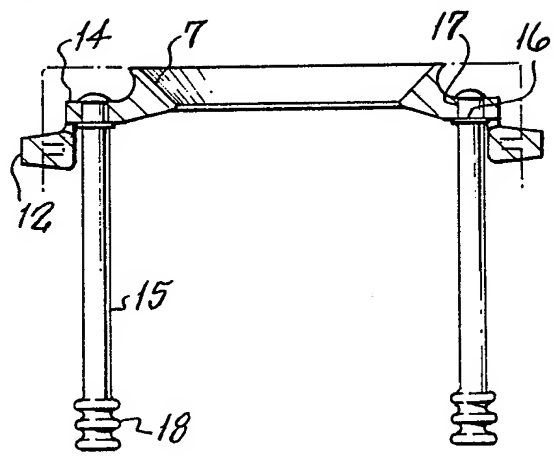

FIG.5

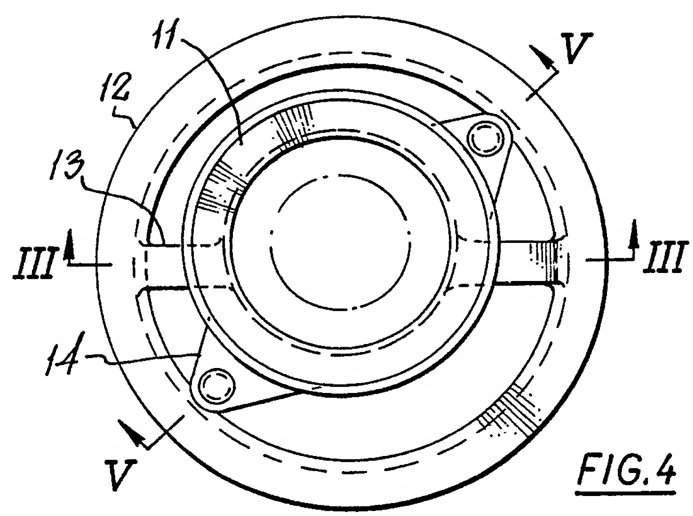

FIG.4

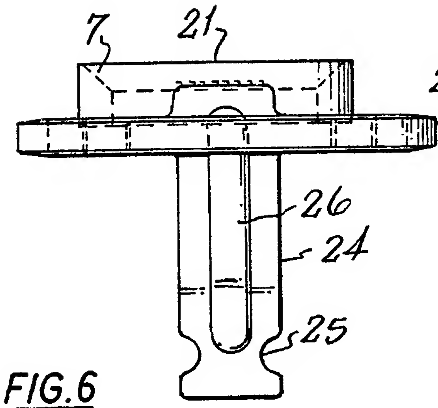

FIG.6

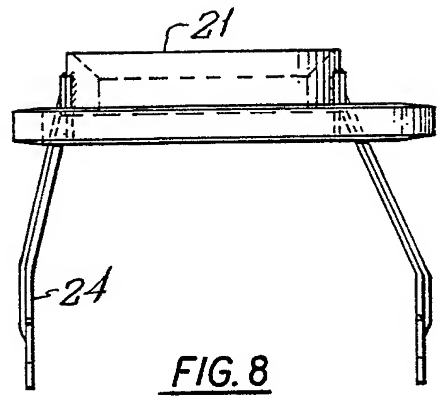

FIG.8

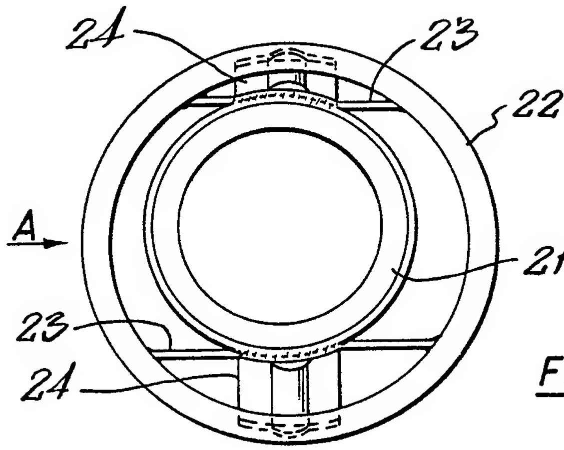

FIG.7

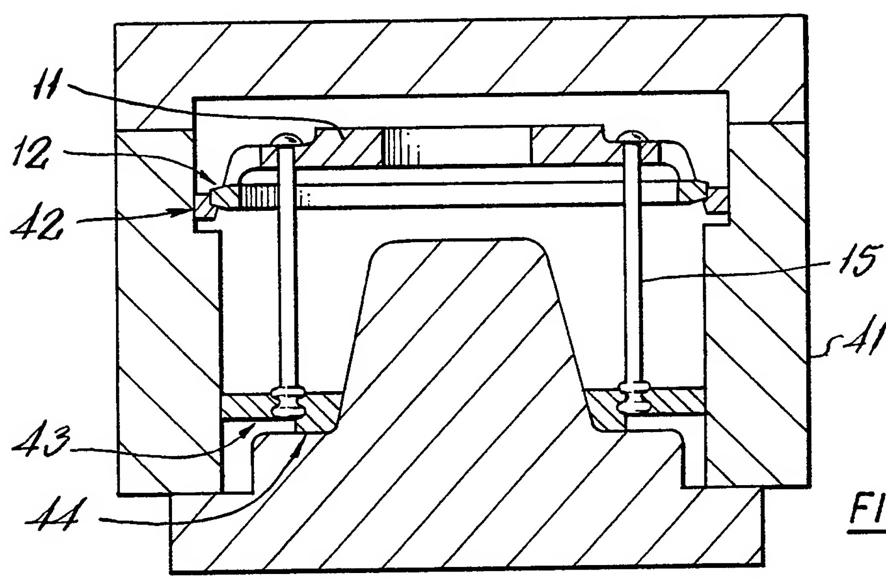

FIG.12

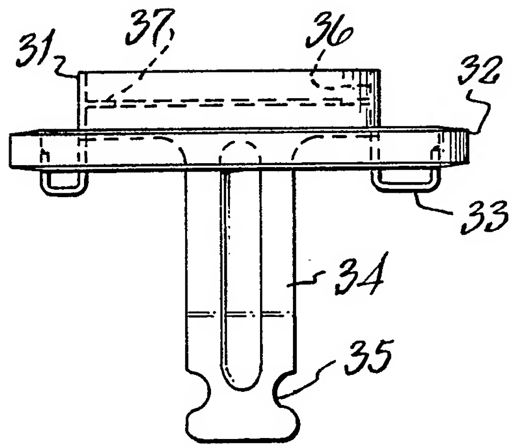

FIG. 9

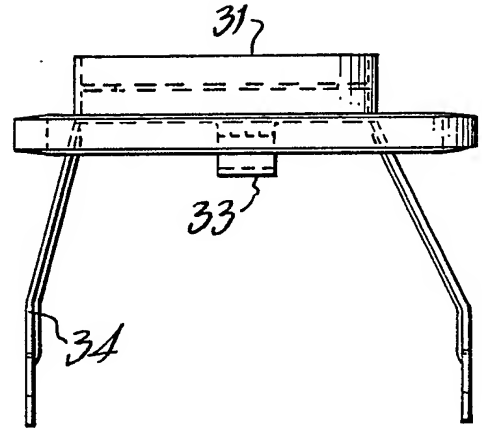

FIG. 11

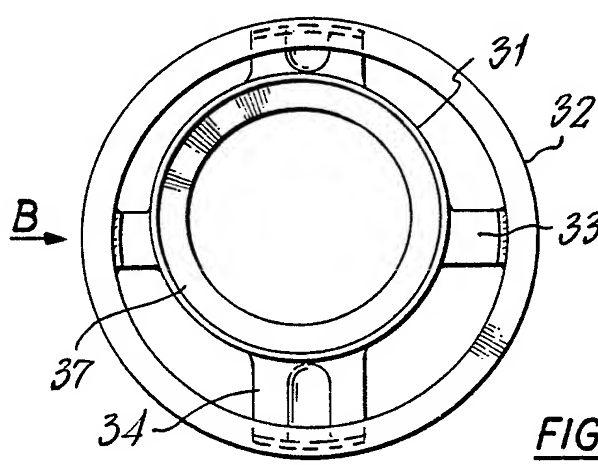

FIG. 10

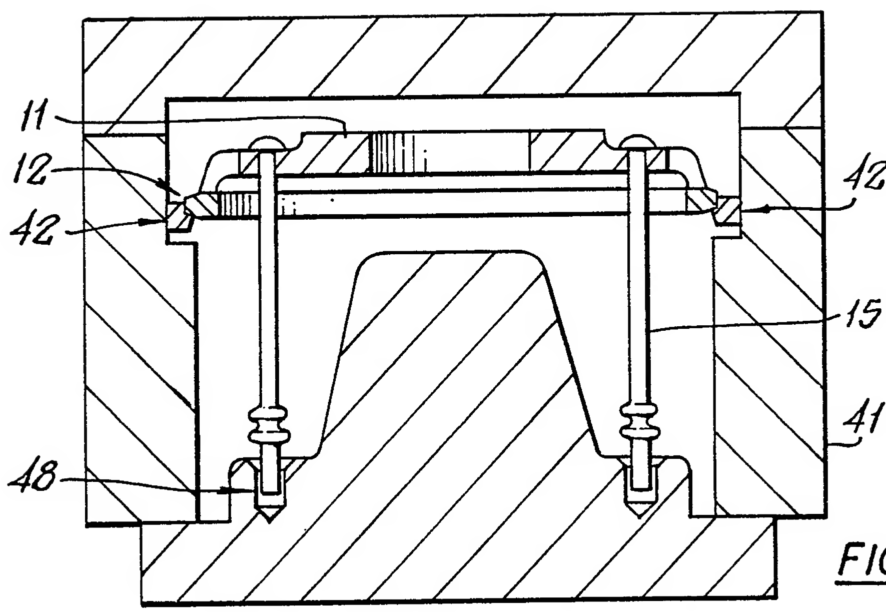

FIG. 14

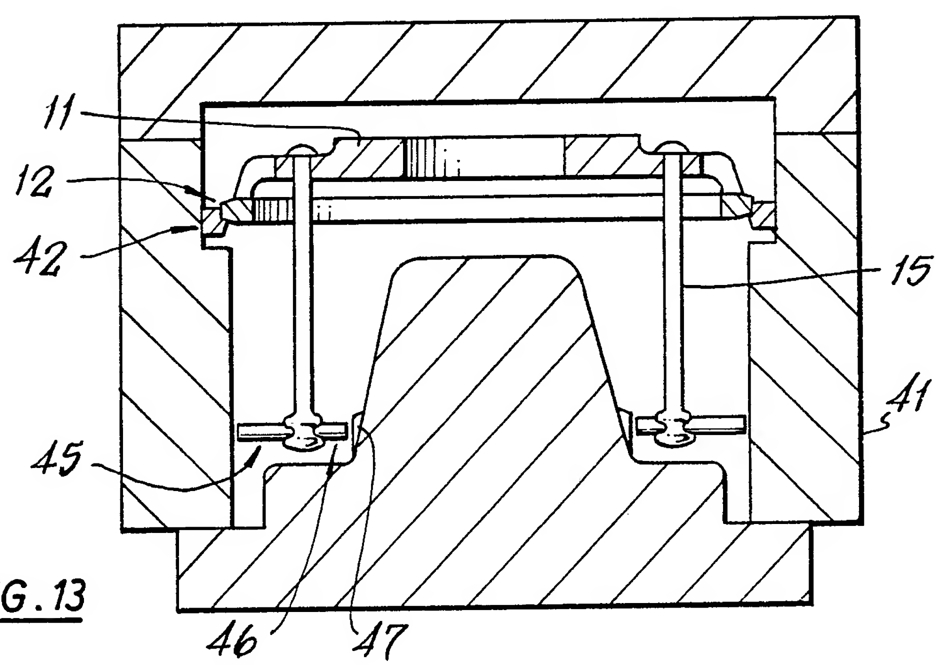

FIG. 13

SPECIFICATION

Pistons for internal combustion engine

This invention relates to pistons for internal combustion engines in particular to inserts incorporated in pistons for internal combustion engines for the purpose of providing armour for combustion chamber bowls and piston ring grooves and to a method of manufacturing such pistons.

It is well known in the piston art to provide inserts respectively for the lip or edge of the combustion chamber bowl and for a piston ring groove, such inserts being of a different metal from that of the body of the piston for the purpose of providing resistance to operating conditions tending to produce cracking of the crown and undue wear of the piston ring grooves. Such inserts are often referred to as "armour". The term "lip" is hereinafter intended to include the edge or rim of both re-entrant and non-re-entrant types of combustion chamber bowls formed in the piston.

One difficulty which has beset attempts to provide lip armour is that, due to the arduous service conditions, the inserts become loosened and various ways of anchoring the insert by mechanical keying or metallurgical bonding have been suggested. One proposal was to join the lip insert to the ring carrier insert by limbs and cast the piston body alloy around the inserts.

A further difficulty is that the most suitable material for the lip insert appears to be a copper base alloy and since the body of the piston is an aluminium alloy, there is incompatibility between the insert and piston body due to likely formation of undesirable metallurgical conditions at the interface of the two alloys especially during casting of the piston body. Composite inserts of two or more metals are more expensive and add to the production operations.

Anchoring the lip insert by means of limbs attached to the insert and embedded in the piston body has achieved some success in tests in which the limbs extend into a portion of the body where the temperature in service is sufficiently low, e.g. 150°C, (that is, creep resistance of the aluminium alloy is sufficiently high) to prevent loosening of the embedded limb and are mechanically keyed and/or metallurgically bonded to the piston body in that portion of the body forming the gudgeon pin boss area. The temperature gradients of pistons are known to those skilled in the piston art.

In the manufacture of pistons, it has been the preferred practice to cast the piston alloy around the lip insert, the insert being provided with either a profile to achieve mechanical keying with the piston alloy or being provided with legs or with connections to the ring carrier insert as the anchoring means, and this has resulted in an interface between the copper alloy and the aluminium alloy.

The present invention seeks to provide a piston having a copper alloy combustion chamber lip insert which can be manufactured by a method which avoids copper alloy/aluminium alloy interfaces in the finished piston whilst providing a secure anchorage for the lip insert.

According to the present invention, a piston for an internal combustion engine comprises a cast aluminium alloy body having a crown portion and a combustion chamber in the crown and having embedded therein a composite insert comprising an annular seat member of a ferrous alloy resistant to conditions of service adjacent the crown portion and coaxial with the combustion chamber, a piston ring carrier insert located on the circumference of the body, at least one support member connecting the seat member to the carrier insert, anchoring means extending from the seat member within the piston body and terminating in a portion mechanically keyed and/or metallurgically bonded to the piston body in a region thereof which, at operating temperatures, is at a temperature such that loosening of the anchoring means is prevented, and a copper alloy combustion chamber lip insert secured to the seat member.

A ferrous alloy which is resistant to conditions of service may be a cast iron containing 3% carbon, 14% nickel, 7% copper and 3% cobalt such as NIRESIST (Registered Trade Mark) or an 18/8 stainless steel, or other suitable austenitic steel.

The lip insert may be secured to the seat member either before or after the casting operation by one of the types of joint hereinafter described.

The composite insert may be constructed in a variety of forms. Preferably, the support member is of relatively thin section and is of a shape such that thermal expansion forces are not transmitted to the ring carrier insert to produce local distortion of the insert, for example, cranked in the vertical plane or arranged tangentially to the seat member. Its function is merely to locate the lip insert in its correct position relative to the ring carrier insert.

The support members may be formed partly on the seat member and partly on the carrier insert and a joint effected between the parts by welding.

The seat member is preferably initially a ring, but a disc can be used and machined to form a ring after the composite insert has been embedded in the piston body. Preferably, the seat member is a nickel cast iron and if desired the ring may be provided with a chamfered inner edge prior to incorporation in the composite insert. Lugs can be conveniently provided on a cast ring for accommodating anchoring means.

Instead of a cast seat member, a sheet metal (stainless steel) ring may be used and this can be made by a pressing operation and can be formed integrally with support members and with legs which function as anchoring means for the seat member.

The piston ring carrier insert is preferably a nickel cast iron ring of conventional form.

The anchoring means are, in one form, legs made from stainless steel rod which are attached to legs provided on the seat member, the ends of the legs being ribbed to provide mechanical keying. In another form, the legs are integral with the seat member, being formed as a casting. In another integral form, the seat member and the legs are formed from sheet stainless steel. Another variation, which combines the seat member and anchoring means, is a stainless steel tube, the upper portion of which functions as a seat member and the lower portion of which, suitably cut away or bent, functions as the anchoring means. Support members could be integral with the tube by cutting and bending the wall or could be welded on. If desired, anchoring means can be combined with the support members e.g. lugs mounting legs and extending radially to contact the carrier ring.

A preferred form of insert comprises an integral, cast ring carrier and lip insert in 18/8 stainless steel, the legs being attached to integral lugs on the lip insert by a mechanical joint e.g. rivetting or screw threading or by a brazed or welded joint.

A suitable composite insert can therefore be a single casting in which all the parts are integral or in a form easily fabricated in which both castings and pressings are used.

As before mentioned, known methods of manufacturing pistons have involved placing the copper alloy lip insert in the mould or die and casting the aluminium alloy around the insert, usually by a die casting process, and this produces an interface between the copper alloy and the aluminium alloy.

According to the present invention, the seat member may be shaped so that it is interposed between the copper alloy and the aluminium alloy. This may be achieved, for example, by means of a chamfered surface, say 45°, on the seat member and a complementary surface on the outer surface of the lip insert, whereby the whole thickness of the lip insert is contained within the seat member. The chamfered surface on the seat member may be machined before or after the piston body is cast and is preferably arranged to leave a minimum wall thickness at the outer part of the seat member.

It is not essential that the interface should be wholly eliminated to ensure a satisfactory emplacement.

Where the seat member is chamfered before incorporation in the piston body, the lip insert can be secured to the seat member by one of the suitable joining methods and the composite insert cast-in in the conventional manner using the locating means in the mould for correct orientation and radial location as hereinafter described.

Alternatively, the composite insert, without the lip insert, can be cast-in in a similar manner and the lip insert secured to the seat member after machining the piston crown to expose or form the seating surface.

Securing the lip insert to the seat member before casting has an advantage in that fewer operations are involved on the cast piston, but on the other hand additional operations are necessary in the preparation of the composite insert although the securing operation may be simpler.

If the lip insert is secured in position after the composite insert is cast-in, it is not necessary to provide a jig for holding the composite insert during joining of the lip insert to the seat member.

It will be apparent that there are several varations in the method by which the piston is manufactured thus permitting flexibility in the choice of production routes.

A method of manufacturing a piston according to the present invention, which has a crown portion and a skirt portion, includes the steps of placing in a piston body mould a resistant ferrous alloy composite insert comprising a seat member, a piston ring carrier insert, at least one support member connecting the seat member to the carrier insert and anchoring means extending from the seat member; supporting the composite insert in the mould by support means carried by the mould engaging the carrier insert whereby the seat member is located near that portion of the mould cavity defining the crown and the anchoring means is located in that portion of the mould cavity defining the skirt portion; casting an aluminium alloy around the composite insert to form a piston body; machining or otherwise treating the crown of the piston body after removal from the mould to expose a seating surface on the seat member and securing to the seating surface a combustion chamber lip insert.

A variation of the above method of manufacturing a piston includes the steps of placing in a piston body mould a resistant ferrous alloy composite insert comprising a seat member, a lip insert secured to the seat member, a piston ring carrier insert, at least one support member connecting the seat member to the carrier insert and anchoring means extending from the seat member; supporting the composite insert in the mould by support means carried by the mould engaging the carrier insert whereby the seat member is located near that portion of the mould cavity defining the crown and the anchoring means is located in that portion of the mould cavity defining the skirt portion; and casting an aluminium

alloy around the composite insert to form a piston body.

Preferably the lip insert is secured to the seating surface by a welding operation, for example, friction welding, laser welding, electron beam welding, or resistance welding. Where the size of the seat member permits, a screw threaded connection may be made between the seat member and the lip insert, the seating surface in this case being a threaded portion on the inner surface of a ring shaped seat member. Other methods of securing the lip insert include brazing, swaging the upper edge of a stainless steel sheet seat member around the outer periphery of the lip insert, and swaging the lip insert around the inturned edge of the stainless steel sheet seat member. In the case of a friction welded joint, the lip insert material may be supplied in the form of a bar or tube which is fed successively to pistons being so welded, the portion welded to the seat member being parted off at the correct angle to weld to the succeeding seat member. The angle of the seating surface to the axis of the seat member is a matter of choice. Suitable lip insert material includes a copper, 0.5% beryllium, 2.5% cobalt alloy, or "Hidurel" 5 (Trade Mark) a copper, 2.5% nickel, 0.5% silicon alloy.

Where the lip insert is secured to the seat member after the piston body has been cut, the combustion chamber may be provided in the crown either before or after the operation to secure the lip insert to the seat member, and in some instances the chamber may be necessary for achieving welding of the lip insert to the seat member by permitting access of a welding device to the appropriate area.

Since the conventional practice of locating the piston ring carrier insert in the mould is by pegs in the wall of the mould, the methods herein described can be easily adapted into current practice. The principal difference from current practice lies in the need for accurately locating the legs of the composite insert in the skirt portion of the mould. There are two requirements in this respect. Firstly, correct orientation is essential to ensure that the legs are located in the desired part of the gudgeon pin boss area and to obtain combustion bowl offset where this is required. Secondly, radial location is desirable to ensure that the anchors do not break through the wall of the finished piston skirt. For this purpose means are provided when the composite insert, with or without the lip insert, is placed in the mould by which the legs are located in predetermined positions in relation to the portion of the mould cavity defining the skirt portion of the piston. Such means include projections within the mould cavity which engage the legs or projections on the legs which engage the walls of the mould cavity. The latter form of projection may be integral with or affixed to the legs. Another means for location may be apertures or grooves or pegs in the base of the mould cavity in which the ends or projections on the ends of the legs are engaged. The piston ring carrier insert is engaged by pegs in the wall of the mould in the method of the invention in the same way as in current practice, and registers, such as notches on the ring carrier for engagement with the pegs, may be provided to ensure correct orientation.

It is also known art to coat the piston ring carrier insert and anchoring means with a bonding metal. One such bonding metal is an aluminium silicon alloy commercially applied by the Alfin process (Trade Mark) and this process or other suitable bonding metal can be applied to the composite insert in the present method.

By way of example, several embodiments of the invention will now be described with reference to the accompanying drawings of which:

Figure 1 is an elevational view of a first type of insert used in the pistons of the invention;

Figure 2 is a plan view of the insert of Fig. 1;

Figure 3 is a cross-sectional elevational view of a second type of insert used in the piston of the invention on the line III of Fig. 4;

Figure 4 is a plan view of the insert of Fig. 3;

Figure 5 is a cross-sectional elevational view of the insert of Fig. 3 on the line V of Fig. 4;

Figure 6 is an elevational view of a third type of insert used in the piston of the invention;

Figure 7 is a plan view of the insert of Fig. 6;

Figure 8 is an elevational view in the direction of the arrow A of Fig. 7;

Figure 9 is an elevational view of a fourth type of insert in the piston of the invention;

Figure 10 is a plan view of the insert of Fig. 9;

Figure 11 is an elevational view in the direction of the arrow B of Fig. 10;

Figure 12 is a cross-sectional elevational view of a mould for a piston showing a first method of locating the legs of an insert as shown in Fig. 3;

Figure 13 is a cross-sectional elevational view of a mould for a piston showing a second method of locating the legs of an insert as shown in Fig. 3, and

Figure 14 is a cross-sectional elevational view of a mould for a piston showing a third method of locating the legs of an insert as shown in Fig. 3.

Referring to the drawings, the first type of insert shown in Figs. 1 and 2 comprises a seat member 1 which is a ring of ferrous metal, either a nickel cast iron marketed under the Registered Trade Mark NIRESIST or an 18/8 stainless steel. The seat member 1 is positioned eccentrically relative to a nickel

cast iron piston ring carrier insert 2 and located in that piston by support members 3. The support members 3 are approximately tangential to the seat member 1 and are in two parts 3a and 3b respectively integrally formed with the seat member 1 and the carrier insert 2 and are butt joined together by welding. Formed integrally with the seat member 1 are anchoring means in the form of cranked legs 4 terminating in anchoring portions 5 and having circumferential ribs and grooves which mechanically key with the piston metal after casting and which can also be precoated with a bonding metal e.g. Alfin (R.T.M.) prior to casting. The legs 4 are of a length such that they extend in the finished piston to a region which at working temperature, has a temperature low enough to prevent loosening; that is, about 150°C. Fig. 1 shows, in a dash line, a copper alloy combustion chamber lip insert 6 in the position in which it will be secured to the seat member 1, or an inclined seating surface 7 machined therein, either before or after the piston has been cast. The lip insert 6 is secured to the surface 7 by friction welding, laser welding, electron beam welding or resistance welding. The outline in dot-dash line 8 represents a combustion chamber co-axial with the lip insert 6 which is machined in the crown of the piston.

The support members 3 are of relatively thin section since they have no anchoring function relative to the seat member 1 and are tangentially arranged to avoid unduly large thermal expansion forces from being transmitted locally to the carrier insert 2. The carrier insert 2 is located on the circumference of the piston body and is bonded thereto by means of a coating of bonding metal applied to the carrier insert 2 before casting. The whole composite insert can be pre-coated with bonding metal.

A second type of insert shown in Figs. 3-5 is in the form of an 18/8 stainless steel casting consisting of annular seat member 11, piston ring carrier 12, cranked support members 13, and lugs 14 formed integrally as a casting. Stainless steel legs 15 are secured to the lugs 14 to form anchoring means by a portion of the leg 15 being received in the aperture 17 with a portion of increased diameter 16, or a collar, abutting the lug and the end peened over. Anchoring portions 18 similar to those of Fig. 1 are provided at the free ends of the legs 15 and these are accommodated in the skirt portion of the piston in the manner described in connection with Fig. 1.

In the seat member 11, a seating surface 7 is formed after the casting operation by a machining operation and a combustion champer lip insert 6 is secured to the surface 7 by a suitable welding operation as in the case of the first type of insert. The cranked support member 13 could, in a variation, be inclined at an angle to the axis of the piston or be curved and the right angle bend eliminated provided that excessive expansion forces are not transmitted to the carrier 12.

The insert shown in Figs. 6-8 is constructed by fabrication methods using castings and pressings. As with the two previous embodiments, an annular seat member 21 and a ring carrier 22 are cast in NIRESIST or 18/8 stainless steel. Support members 23 combined with legs 24 are pressed from stainless steel sheet, and are secured to the seat member 21 and the ring carrier 22 by welding. The legs 24 are profiled at the end portion 25 to mechanically key with the piston metal, and a rib 26 is provided for stiffness. A seating surface 7 is machined in the seat member 21 after casting the piston for accommodation of a lip insert. In a variation, the support members 23 and the legs 24 can be separate entities which are joined together during the welding operation. The support members 23 are of thin gauge material since they merely hold the seat member 21 in the required position during the casting of the piston body.

In the fourth example of an insert for use in the method of the invention, the use of metal pressings is further extended. As shown in Figs 9-11, a seat member 31 is formed from stainless steel sheet by a pressing having the shapes of the support members 33 and the ribbed legs 34 with cut-away portions 35 carried on a strip portion which, when bent into a ring and welded, forms the seat member 31.

The support members 33 are bent into a U-shape and the ends welded to the stainless steel or NIRESIST ring carrier 32. A vertical surface 36 is utilised as seating surface for a combustion chamber lip insert after machining away piston metal. Alternatively, prior to casting, the seat member 31 can be formed with an internal flange 37 which serves as a seat surface to which a combustion chamber lip insert is welded.

In Fig. 12, which shows one method according to the invention for manufacturing a piston, an insert of the type illustrated in Figs. 3-5, is shown disposed within a mould 41 which is jointed in the central vertical plane. Mounted in the internal lateral wall are pegs 42 on which is supported the ring carrier 12 of the insert, the pegs engaging notches on the ring carrier so that the seat member 11 is near the top of the mould and correctly orientated. The legs 15 extend downwardly into the skirt portion of the mould and are located radially and rotationally by anchor locators 43 and 44 carried by the mould. In a variation, only one of the anchor locators is required for each leg. The contacting portion of the anchor locators is a V notch.

A further variation is shown in Fig. 13 in which instead of anchor locators 43 and 44 in

the mould, radial projections 45, 46 on the legs 15 provide means for locating the legs 15 in their correct places. Only one of the projections 45 or 46 may be used as an alternative. The projections 45 or 46 can be integral with the leg 15 or may be attached thereto, and should remain unmelted by the piston metal when cast into the mould. If desired, a portion 47 of the wall of the mould may be built up to provide a locating surface for the projection 46.

Fig. 14 shows another manner in which the legs are correctly located in the mould. For each leg 15, an aperture 48 is provided in the lower part of the mould into which the end of the leg 15 fits. Instead of an aperture 48, a radial groove may be used, the terminal portion of which bears against the leg 15 to hold it in the correct position.

CLAIMS

1. A piston for an internal combustion engine comprising a cast aluminium alloy body having a crown portion and a combustion chamber in the crown and having embedded therein a composite insert comprising an annular seat member of a ferrous alloy resistant to conditions of service adjacent the crown portion and coaxial with the combustion chamber, a piston ring carrier insert located on the circumference of the body, at least one support member connecting the seat member to the carrier insert, anchoring means extending from the seat member within the piston body and terminating in a portion mechanically keyed and/or metallurgically bonded to the piston body in a region thereof which, at operating temperatures, is at a temperature such that loosening of the anchoring means is prevented, and a copper alloy combustion chamber lip insert secured to the seat member.

2. A piston according to claim 1 wherein the lip insert is secured to the seat member by a welded joint.

3. A piston according to claim 1 or claim 2 wherein the seat member is a cast iron containing 3% carbon, 14% nickel, 7% copper and 3% cobalt.

4. A piston according to any of the preceding claims wherein the support member connecting the seat member and the ring carrier insert is of a shape such that thermal expansion forces are not transmitted to the ring carrier insert to cause local distortion thereof.

5. A piston according to claim 4 wherein the support member is cranked in the vertical plane.

6. A piston according to claim 4 wherein the support member is arranged substantially tangential to the seat member.

7. A piston according to claim 1 wherein the support members are formed partly on the seat member and partly on the carrier insert and the parts are joined together by a welded joint.

8. A piston according to claim 1 wherein the seat member is a sheet metal pressing of 18/8 stainless steel having integral support members and anchoring members.

9. A piston according to claim 1 wherein the anchoring means comprise rods mounted at one end in lugs projecting from the seat member and terminating at the other end in mechanical keying means.

10. A piston according to claim 1 wherein the anchoring means comprise legs integral with the seat member.

11. A piston according to claim 1 wherein the composite insert is a single casting comprising seat member, ring carrier insert, support members connecting seat member and carrier insert and anchoring means extending from the seat member.

12. A piston according to claims 9-11 wherein the anchoring means include radial projections.

13. A piston according to claim 1 wherein the anchoring means and the support members are integral.

14. A method of manufacturing a piston according to claim 1 which has a crown portion and a skirt portion, including the steps of placing in a piston body mould a resistant ferrous alloy composite insert comprising a seat member, a piston ring carrier insert, at least one support member connecting the seat member to the carrier insert and anchoring means extending from the seat member; supporting the composite insert in the mould by support means carried by the mould engaging the carrier insert whereby the seat member is located near that portion of the mould cavity defining the crown and the anchoring means is located in that portion of the mould cavity defining the skirt portion; casting an aluminium alloy around the composite insert to form a piston body; machining or otherwise treating the crown of the piston body to expose a seating surface on the seat member; and securing to the seating surface a combustion chamber lip insert.

15. A method of manufacturing a piston according to claim 1 which has a crown portion and a skirt portion, including the steps of placing in a piston body mould a composite insert comprising a seat member of ferrous alloy resistant to conditions of service, a copper alloy lip insert secured to the seat member, a piston ring carrier insert, at least one support member connecting the seat member to the carrier insert and anchoring means extending from the seat member; supporting the composite insert in the mould by support means carried by the mould engaging the carrier insert whereby the seat member is located near that portion of the mould cavity defining the crown and the anchoring means is located in that portion of the mould cavity

defining the skirt portion; and casting an aluminium alloy around the composite insert to form a piston body.

16. A method according to claim 14 or 15 wherein the lip insert is secured to the seating surface by a welding operation.

17. A method according to claim 16 wherein the welding operation is friction welding or laser welding or electron beam welding or resistance welding.

18. A method according to claim 17 wherein a bar or tube of suitable copper alloy having a correctly angled engaging surface is fed to engage a seating surface, a weld formed by friction and the welded portion being parted off so as to provide the bar or tube with an engaging surface of the correct angle to effect friction welding to a subsequent seating surface.

19. A method according to claim 14 or 15 wherein the lip insert is secured to the seating surface by a screw thread.

20. A method according to claim 14 or 15 wherein the means for accurately positioning legs of a composite insert in the mould cavity are provided in the portion of the mould cavity defining the skirt portion of the piston body.

21. A method according to claim 20 wherein the said means include projections in the mould which engage the legs.

22. A method according to claim 20 wherein the said means include projections on the legs which engage the wall of the mould.

23. A method according to claim 20 wherein the said means include an aperture or slot in the mould in which the end portions of the legs are received.

24. A method according to claims 14 to 23 wherein at least the anchoring portion of the composite insert are coated with a bonding metal prior to placing in the mould.

25. A composite insert for use in the method according to claim 14 comprising a seat member for a combustion chamber lip insert, a piston ring carrier insert, a support member connecting the seat member and carrier insert, and anchoring means secured to the seat member and terminating in a portion adapted to key mechanically with metal cast around it, the composite insert being made entirely of a resistant ferrous metal.

26. A composite insert for use in the method according to claim 15 comprising a seat member, a lip insert secured to the seat member, a piston ring carrier insert, a support member connecting the seat member and carrier insert, and anchoring means secured to the seat member and terminating in a portion adapted to key mechanically with metal cast around it, the composite insert except for the lip insert being made of a ferrous alloy resistant to conditions of service, and the lip insert being made of a copper alloy.

27. A piston for a internal combustion engine substantially as hereinbefore described with reference to Figs. 1-11 of the accompanying drawings.

28. A method of manufacturing a piston substantially as hereinbefore described with reference to Figs. 12-14 of the accompanying drawings.

29. A composite insert substantially as hereinbefore described with reference to Figs, 1-11 of the accompanying drawings.

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TITLE: Internal combustion engine piston with composite insert includes a piston ring carrier, chamber bowl lip insert and anchoring limbs for seat member

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PATENT-ASSIGNEE: PERKINS ENGINES LTD[PERKN]

PATENT-FAMILY:

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BASIC-ABSTRACT:

A piston has a cast-in composite insert comprising an annular seat of a ferrous alloy coaxial with the combustion chamber, a piston ring carrier and support members connected between the seat and carrier. Anchoring limbs extend from th seat within the cast Al alloy piston body to a suitably cool region of the body. A Ca alloy combustion chamber lip insert is secured to the seat.

Armour is provided for combustion chamber bowls and piston ring grooves. The lip insert can be secured to the cast-in composite insert before or after the piston body is cast using laser, electron beam, friction or resistance welding or mech. jointing or brazing. The seat member can be exposed by machining.

TITLE-TERMS: INTERNAL COMBUST ENGINE PISTON COMPOSITE INSERT RING CARRY CHAMBER BOWL LIP ANCHOR LIMB SEAT MEMBER

DERWENT-CLASS: M22 M27 P53 Q52

CPI-CODES: M22-G03K;